

AMENDMENTS TO THE SPECIFICATION

Please change the specification as follows:

[0007] Radio transmission systems are available for transmitting in the high UHF band, but these systems are not generally viewed as being useful in mines or tunnels. For example, United States Patent No. 6,072,991, describes a terrestrial line-of-sight communication system that transceives in a frequency range of 2 GHz to 94 GHz. ~~The '991 system is not specifically used in tunnels or mines, and transmissions at these higher frequencies are generally not understood to be useful in tunnels or mines.~~

[0010] The wireless communications system is used to communicate in confined spaces or enclosures, such as mines, tunnels, industrial enclosures, buildings and the like. A pair of transceivers are configured to transmit and receive signals through the enclosure at frequencies ranging from 5 GHz to 15 GHz, more preferably from 8 GHz to 12 GHz, and most preferably at 10 GHz plus or minus three percent. It has been discovered, for example, that transmission at these frequencies permit transmission at distances in excess of thirteen miles through concrete lined water conveyance tunnels and that such tunnels have a limited channeling effect at these frequencies. This level of performance may be obtained in systems that transmit at a power output of 100 milliwatts, 35 milliwatts, or less, which is generally regarded as a safe level of RF exposure for workers. This level of power consumption means that each transceiver may operate for an extended period of time while being supplied by a 12 volt ~~automotive type~~ battery.

~~[0020] Fig. 7 is a plan view of a schematic showing Soap Lake Siphon located near Ephrata, Washington;~~

~~[0021] Fig. 8 is a vertical section view of a schematic showing the Soap Lake Siphon;~~

~~[0022] Fig. 9 shows experimental data that confirms superior performance of microwave propagation in Soap Lake Siphon; and~~

~~EXAMPLE 2~~

~~SIGNAL PROPAGATION IN SOAP LAKE SIPHON~~

~~[0033] The Bureau of Reclamation operates Soap Lake Siphon, which is a water conveyance tunnel located near Ephrata, Washington. The tunnel is twenty-five feet in diameter, and two and one-half miles long. The Soap Lake Siphon was selected because it has a complex geometry presenting significant changes in direction in both the vertical and horizontal planes. The Soap Lake Siphon has two different types of linings that include concrete and steel-lined concrete. Fig. 7 is a plan view of the tunnel schematic showing horizontal changes in direction. Fig. 8 is a sectional tunnel schematic showing changes in elevation in respect to a hydrologic gradient. The water level was sufficiently lowered to permit access by Bureau personnel. Soap Lake Siphon was selected for its geometry, which differs from the straight bore Azotea Tunnel. Geometric features include:~~

- ~~• a 45° elbow 800 (Fig. 8) between points A and B;~~
- ~~• a 25° corner 700 (Fig. 7) and a 60° drop 802 (Fig. 8) between points B and C;~~
- ~~and~~
- ~~• a 45° corner 702 between points C and D.~~

~~The tests that were performed in Example 1 were replicated in the Soap Lake Siphon, except fewer radio types were used, test distances were shorter, and SHF transmission occurred at 10 milliwatts. The comparative study involved commercially available radios transmitting at 600 MHz, 900 MHz. The super high frequency transmitter was evaluated at 2.0 GHz, 6.0 GHz, 11.0 GHz, and 16.0 GHz. Compatible receivers were positioned at successive distances into the tunnel including distances of 100 feet (A); 2,200 feet (B); 2,900 feet (C), and 5,700 feet (D) feet into the tunnel.~~

~~Fig. 9 shows the received signal strengths as a function of distance. The results shown in Fig. 9 indicate that the larger diameter of the Soap Lake Siphon produced less signal attenuation in the lower frequencies than did Azotea tunnel on straight runs, and that the channeling effects of the tunnel permit signals to travel around geometric features of the tunnel. Extrapolation of the curves shows substantial convergence at about 6000 feet; however, the SHF frequencies were transmitted at lower power of 10 milliwatts.~~

~~[0037] A lock recapture circuit 1034 is activated to perform frequency sweep control if a signal lock with a remote transceiver (not shown) is lost. If activated, the~~

lock recapture circuit 1034 transmits a ramp V_p that causes microwave generator circuit 1032 to sweep over the entire available frequency range in an attempt to recapture lock with the remote transceiver. This is possible because a pair of transceivers 1000 operate in a full duplex mode through which both transceivers continuously or periodically transmit. Signal strength and center tuning is used to determine whether frequency lock exists on the basis of received signals. The lock recapture circuit 1034 may be optionally provided with an auto/manual switch that selectively enables or disables automatic scanning upon loss of lock. Thus, the user may use the manual frequency control 1028 to scan for audible signals if received communications signals 1022 are too weak for detection by the loss of lock circuit 58.

[0038] A summation device 1036 sums signals from the amplifier 1026, manual frequency control 1028, AFC 1030 and lock recapture circuit 1034. The sum of these signals is the modulation signal V_m , which is input to the microwave generator circuit 1032 located in the transmit/receive module 1002. The microwave generator circuit 1032 generates microwave energy at a frequency from 5 GHz to 15 GHz. This microwave energy is modulated by the modulation signal V_m . The resulting microwave signal is applied to antenna 1038 and output as a communications signal ~~406~~1022. The antenna 1038 may, for example, be a horn-type or high gain directional antenna.

[0039] Incoming communications signals ~~406~~1022 are received by antenna 1038 and applied to a microwave receiver downconverter circuit 1032. By way of example, the microwave generator/modulator circuit and the microwave receiver downconverter circuit 1032 may be purchased in a combined package that is commercially available as the GunnplexerTM, which is available from Microwave Associates of Burlington, Massachusetts. The downconverted signal, V_{ds} , is applied to a mixer/IF amplifier/demodulator circuit 1042 which, in turn, produces three different signals. One such signal is input to the AFC 1030, which outputs this signal to summation device 1036. Another signal is input to meter circuits 1044, which process the signal to provide voltage input to meters 1046 including one meter showing relative signal strength of the received communications signal ~~406~~1022 and another meter indicating whether the transceiver 1000 is tuned to the center frequency

of the received signal or mistuned to either side of the center frequency. The third signal from mixer/IF amplifier/demodulator circuit 1042 is a received audio signal V_{as} , which is input to an audio amplifier 1048 and a call signal detect circuit 1050. The audio amplifier 1048 amplifies the signal V_{as} , which is applied to an audio output device 1052, i.e., a speaker, which by way of example may be incorporated in a set of headphones that are utilized for the hearing of voice transmissions contained in communications signals ~~106~~1022. Due to the nature of duplex operation, the user is also able to hear himself or herself speak through audio output device 1052.

[0043] A loss of lock detect circuit 1058 monitors the voltage level that is applied to the signal strength and center tune meters in meter circuit 1046. If the signal strength falls below a minimum level or if the tuning moves too far from center frequency, the loss of lock detect circuit 1058 activates the call alarm circuit 1056 ~~on both transceivers~~. The visual and/or audio signal presentation that is activated by loss of lock detect circuit 1058 may be modulated differently than when the call alarm circuit 1056 is activated by call signal detect circuit 1050, in order that the user may distinguish between the different modes of activation. The lock recapture circuit 1034 may be optionally provided with an auto/manual switch that selectively enables or disables automatic scanning upon loss of lock. Thus, the user may use the manual frequency control 1028 to scan for audible signals if received communications signals 106 are too weak for detection by the loss of lock circuit 1058.

AMENDMENTS TO THE DRAWINGS

Please omit Fig. 7

Please omit Fig. 8

Please omit Fig. 9

No new matter is added to any of the drawings.